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Climate forcing of the secondary organic aerosols

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In recent years, several field measurement campaigns have highlighted the importance of the organic fraction of aerosol mass, and with such spatial diversity that one may assert that these aerosols are ubiquitous in the troposphere, with particular importance in continental areas. Investigation of the chemical composition of organic aerosol remains a work in progress, but it is now clear that a significant portion of the total organic mass is composed of secondary organic material, that is, aerosol that is not emitted to the atmosphere in particulate form, but formed in situ from gaseous volatile organic carbon (VOC) precursors. A number of such precursors, of both biogenic and anthropogenic origin, have been identified. Experimental, inventory building and modelling studies have followed, with the empirical effort elucidating the chemical pathways that lead to secondary organic aerosol (SOA) formation, and providing means to estimate the aerosol yields from a given precursor-oxidation reaction. Other empirical studies have focused on the biogenic precursors, and have found that such emissions depend upon plant species, temperature, and, in certain cases, photosynthetically active radiation. Global inventories of anthropogenic VOC emissions, and of biogenic VOC emitter species distribution and their emission potential have been constructed. Building upon the results of empirical and inventory-building efforts, global models have been developed that provide estimates of global SOA precursor VOC emissions, SOA formation and atmospheric burdens of these species. Yet few attempts have been made to estimate the climate forcing due to these aerosols. Here we describe both the direct (radiative) aerosol forcing and the indirect forcing due to changes in cloud properties as calculated with the global aerosol-climate model ECHAM5/HAM.